CHAPTER

1

A First Look at Windows 2000 Professional

After reading this chapter and completing the exercises, you will be able to:

- Describe the Windows 2000 product family
- Describe the major features of the Windows 2000 environment
- Understand the architecture of Windows 2000
- Define the minimum system requirements for Windows 2000 Professional
- Understand the two major networking models under which Windows 2000 can be used

The technological achievements in the computing world are advancing faster than ever before. Consumers can purchase computer systems with power and capabilities that were mere fantasies just a few years ago, and do so at a lower cost. Microsoft has endeavored to maintain a competitive edge on these new powerful systems by continuing to evolve its operating system products. The latest manifestation of the Microsoft operating system product line is Windows 2000, which is a network and desktop operating system designed to take advantage of new hardware and the Internet to produce unsurpassed performance for network activities and application execution.

The Microsoft Networking Family

The Microsoft networking family is a collection of **operating systems** from Microsoft that offers the capability to participate in a network as either a **server** or **client**. This family includes operating systems currently in production as well as older products. Products in production include Windows 2000 and **Windows 98**; older family members include **Windows NT**, **Windows 95**, and **Windows for Workgroups**.

Windows 2000 Family

The Windows 2000 product family, the latest from Microsoft, brings together the best of Windows NT and Windows 95/98 with advanced Internet, security, and connectivity technologies. The result is a network and desktop operating system that offers unsurpassed functionality, security, resource management, and versatility. Windows 2000 consists of four products: **Windows 2000 Server**, **Windows 2000 Advanced Server**, **Windows 2000 Professional**, and **Windows 2000 Datacenter Server**.

Windows 2000 Server

Windows 2000 Server is the successor to Windows NT 4.0 Server and is the core component in a client/server network environment. It establishes and maintains a **domain** in which other servers and thousands of clients can easily and productively participate. One of the most significant improvements to Windows 2000 Server as compared to Windows NT 4.0 Server is the introduction of **Active Directory**. Active Directory is a mechanism to centralize network resource and security management, administration, and control. Active Directory combines previously separate organizational structures into a single manageable whole that includes users, groups, security, services, network resources, and more.

In addition to improved security and resource management, Windows 2000 Server offers many other improvements for networks. These include Web and Internet services that enable improved access to existing resources and that simplify and strengthen the ability to host services and resources over intranets and the Internet. Windows 2000 Server is ideal for supporting network applications on small to medium-sized domains. Windows 2000 Server supports up to four processors out of the box and up to 4 GB of RAM.

Windows 2000 Advanced Server and Datacenter Server

Windows 2000 Advanced Server is an enhanced version of Windows 2000 Server focused on the high-end use of multiple processors and/or clustered processors. Advanced Server was developed to host high-end network applications, such as distributed databases, and to provide unparalleled performance in which instant access, wide availability, scalability, and fault tolerance are required.

Windows 2000 Datacenter Server offers even greater power and capabilities. It is designed for data warehousing, complex mathematical analysis, three-dimensional rendering, real-time transaction processing, and enterprise Internet Service Provider (ISP) Web site hosting.

Windows 2000 Advanced Server supports up to eight processors out of the box and up to 8 GB of RAM. Special Datacenter Server versions supporting up to 32 processors and 64 GB of RAM are available.

Windows 2000 Professional

Windows 2000 Professional is the standalone or client version of Windows 2000. Designed for speed and reliability, Windows 2000 Professional brings a solid computing environment to desktop and mobile computers. Windows 2000 Professional is the ideal client operating system for connecting to and interacting with a Windows 2000 domain. The majority of this book focuses on this product.

Windows 98

Windows 98 is the latest home computer operating system from Microsoft. In the second quarter of 1999, Microsoft released an updated version of the product, called Windows 98 SE (Second Edition). It contained several code patches and several new utilities and related software products.

All of the most important Windows 98 update items are available for download from the Windows 98 Web area (*www.microsoft.com/Windows*), but the new bells and whistles are available only when you purchase the upgrade.

Windows 98 offers home users an easy-to-use computing environment for work productivity, Internet access, education, and entertainment. Windows 98 focuses on ease of use and a wide range of hardware support. It lacks security features and fault tolerance. Windows 98 does not have as stringent minimal system requirements as Windows NT or Windows 2000 Professional and is thus often the preferred operating system for older or less powerful computer systems.

Microsoft has plans to develop a home user version of Windows 2000, to be released in 2001 or 2002.

Earlier Windows Operating Systems

As Microsoft releases updated and improved products to keep up with technological advances, its previous releases are pushed to the side. In that context, Windows 2000 has recently pushed Windows NT aside. Many products that are still modestly supported by Microsoft but are no longer actively developed are still widely used in networks.

Microsoft would like users to upgrade to the latest product releases as soon as possible to bring networks into compliance with current technologies. However, the expense of new products is often prohibitive for companies and individuals. Generally, you should upgrade only when technical support for your existing platform is no longer cost-effective and when the needs of your work tasks exceed the capabilities of your current system.

Windows NT, like Windows 2000, is a family of network operating systems: Windows NT Workstation, Windows NT Server, and Windows NT Enterprise Edition. These three versions serve functions similar to those of the Windows 2000 variants. If you would like more information on Windows NT, see the Windows NT Web area at *http://www.microsoft.com/windows/* or *Guide to Windows NT Workstation 4.0*, by Ed Tittel, Christa Anderson, and David Johnson (Course Technology, 1998, ISBN 0-7600-5098-8).

THE WINDOWS 2000 ENVIRONMENT

The Windows 2000 operating environment is a hybrid of Windows NT and Windows 98. The combination of the Windows NT core reliability and security with the Windows 98 **Plug and Play** capability and connectivity results in an operating system that is unsurpassed in function and features. The following sections highlight many of the characteristics of the Windows 2000 environment.

Portability

Windows 2000 can be installed on Pentium class (or higher, or equivalent compatible clones) x86 CPUs.

Windows NT 4.0 did support PowerPC and MIPS R4x00 CPUs. However, in January 1997, Microsoft announced the termination of continued support for these CPU types. Thus, these systems hosting Windows NT 4.0 cannot be upgraded to Windows 2000. Originally, Microsoft planned Windows 2000 support for the Compaq Alpha platform. Unfortunately, all Alpha platform develpment was cancelled after Compaq decided to discontinue Windows NT/2000 development on the Alpha.

Multitasking

One of the great features of Windows 2000 is **multitasking**—a mode of CPU operation in which a computer processes more than one task at a time. Windows 2000 supports two types of multitasking—preemptive and cooperative. **Preemptive multitasking** defines a processor scheduling regime in which the OS maintains strict control over how long any execution thread (a single task within a multithreaded application, or an entire single-threaded application) may take possession of the CPU. The reason this scheduling regime is called preemptive is because the operating system can decide at any time to swap out the currently executing thread should another, higher-priority thread make a bid for execution (the termination of the lower-priority thread is called preemption). Windows 2000 supports multiple threads, and allows multiple duties to be spread among multiple processors. Most native Windows 2000 applications are written to take advantage of threads, but older applications may not be as well equipped.

Cooperative multitasking defines a processor scheduling regime wherein individual applications take control over the CPU for as long as they like (because this means that applications must be well-behaved, this approach is sometimes called "good guy" scheduling). Unfortunately,

this type of multitasking can lead to stalled or hung systems, should any application fail to release its control over the CPU. **Windows 3.x** is one of the best examples of this type of environment because it runs on top of **MS-DOS**, a single-threaded operating system. In contrast, native 32-bit Windows 2000 applications are not hindered by such limitations. The default for Windows 2000 is that all 16-bit Windows applications run within a single virtual machine, which is granted only preemptive CPU access. This guarantees that other processes active on a Windows 2000 machine will not be stymied by an ill-behaved Windows 3.x application.

Multithreading

Multithreading refers to a code design in which individual tasks within a single process space can operate more or less independently as separate, lightweight execution modules, called **threads**. (Threads are called lightweight execution modules because switching among or between threads within the context of a single process involves very little overhead, and is therefore extremely quick.) A thread represents the minimal unit of code in an application or system that can be scheduled for execution.

Within a process, all threads share the same memory and system resources. A **process**, on the other hand, is a collection of one or more threads that share a common application or system activity focus. Processes are called heavyweight execution modules because switching among processes involves a great deal of overhead, including copying large amounts of data from RAM to disk for outbound processes, and repeating that process to copy large amounts of data from disk to RAM for inbound ones. Under Windows 2000, it normally takes more than 100 times longer to switch among processes than it does to switch among threads.

Multithreading allows an operating system to execute multiple threads from a single application concurrently. If the computer on which such threads run includes multiple CPUs, threads can even execute simultaneously, each on a different CPU. Even on single-CPU computers, threaded implementations speed up applications and create an environment in which multiple tasks can be active between the foreground (what's showing on the screen) and the background (what's not on screen). Windows 2000 is unusually adept and efficient at multithreading.

File Systems

Windows 2000 supports three file systems:

- ***FAT (file allocation table)***: The file system originally used by DOS (actually, the Windows 2000 implementation is an extension of Virtual FAT, or VFAT, which includes support for long filenames and 4 GB files and volumes). Windows 2000 FAT is also known as FAT16.
- ***FAT32***: An enhancement of the FAT16 file system developed for Windows 95 OSR2 and included in Windows 98. Windows 2000 includes support for FAT32 primarily to gain the 32 GB file and volume size improvement over FAT16. FAT32 volumes created by Windows 95 OSR2 or Windows 98 can be mounted under Windows 2000.

- ***New Technology File System (NTFS)***: A high-performance, secure, and object-oriented file system introduced in Windows NT. This is the preferred file system for Windows 2000.

Versions of Windows NT up through 3.51 (that is, not including 4.0) supported the HPFS (High Performance File System), originally present in OS/2 and LAN Manager. Windows 2000 does not support HPFS.

Active Directory

Active Directory is a new control and administration mechanism of Windows 2000. Active Directory is supported by Windows 2000 Server and Advanced Server to create, sustain, and administer a domain or group of related domains. Active Directory combines the various aspects of a network—namely users, groups, hosts, clients, security settings, resources, network links, and transactions—into a manageable hierarchical organizational structure. Active Directory simplifies network administration by combining several previously distinct activities, including security, user account management, and resource access, into a single interface.

Windows 2000 Professional does not include support utilities for installing or managing Active Directory. However, by joining a domain, Windows 2000 Professional will interact with the Active Directory for all resource- and security-related communications.

Security

Windows 2000 incorporates a variety of security features, all of which share a common aim: to enable efficient, reliable control of access to all resources and assets on a network. To that end, the Windows 2000 security features begin with a protected, mandatory logon system. These features extend to include memory protection, system auditing over all kinds of events and activities, precise controls on file and directory access, and all kinds of network access limitations.

Windows 2000 is an operating environment developed to address the following business security needs:

- Enterprise isolation
- Multilevel security
- Auditing and resource tracking
- Isolation of hardware-dependent code

Also, numerous third-party companies offer security enhancements or extensions to Windows 2000 that cover everything from biometric authentication add-ons (so fingerprints or retinal scans can be used to control system access) to firewalls and proxy servers to isolate Windows 2000-based networks from the Internet or other publicly accessible networks.

One of the more popular enhancements to the Windows 2000 security system is the inclusion of the **Kerberos** v5 authentication protocol. Basically, Kerberos is used to authenticate

a client to a server (that is, to ensure that they are both valid members of a domain) before communication between them is permitted.

Multiple Clients

Windows 2000 Server supports a wide variety of potential client platforms that can interact with resources on a Windows 2000-based network. Please note that the following list of clients includes two third-party operating systems, as well as a broad range of Microsoft products.

- Windows 95 and Windows 98
- Windows 3.x and Windows for Workgroups
- MS-DOS
- Macintosh
- OS/2
- Windows NT Workstation
- Windows 2000 Professional

If TCP/IP (Transmission Control Protocol/Internet Protocol) is used on a Windows 2000-based network, any computer that supports this protocol can function as a client, even if with only limited capabilities. Because nearly all versions of Unix include built-in support for TCP/IP, this extends the reach of Windows 2000-based networks considerably.

Multiple Processors

Windows 2000 supports true **multiprocessing**—support for up to two CPUs is included in every standard version of Windows 2000 Professional. Only Windows 2000 Server and Advanced Server have options for more than four CPUs, and then only in specialized versions.

On multiple-CPU systems, as many processes or threads as there are CPUs can execute simultaneously. This means that multiple applications can execute at the same time, each on a different processor. The network administrator can adjust the priority levels for different processors, to make sure that preferred applications get a bigger slice of the CPUs that are available.

Compatibility

Windows 2000 supports a wide range of applications. This is accomplished through application subsystems that emulate the native environment of each application type. In other words, a virtual machine is created for applications in such a way that they are fooled into seeing themselves as the sole inhabitant of a computer system that matches their execution needs. Windows 2000 supports the following application types:

- DOS 16-bit
- Native 32-bit (**Win32**)

- **OS/2** 1.x character-based
- POSIX.1-compliant (**POSIX** is a platform-independent OS specification based on Unix; 1.1 represents the lowest level of recognized POSIX compliance.)
- Windows 3.1 and Windows for Workgroups 16-bit (**Win16**)

Windows 2000 Professional supports most Windows 95/98-based programs, in particular Windows 32-bit business programs. It also supports MS-DOS-based programs, except for those that access the hardware directly.

Storage

Windows 2000 Professional supports huge amounts of hard disk and memory space:

- *RAM*: 4 GB Intel (*Note*: Only half of the maximum RAM is available to any single process, including the OS kernel itself.)
- *Hard disk space*: 2 TB (terabytes) for NTFS volumes, 32 GB for FAT32 volumes, and 4 GB for FAT16 volumes

Connectivity

Windows 2000 supports a wide variety of networking protocols. The following protocols are included in the core OS:

- ***AppleTalk***: The protocol suite developed by Apple for use with Macintosh computers. *Note*: Windows 2000 Professional can use AppleTalk to communicate with Apple printers and similar devices, but (unlike Server) it does not support client services for Macintosh users. In addition, AppleTalk remote access is supported by the AppleTalk Remote Access Protocol (ARAP) and the AppleTalk Control Protocol (ATCP).
- ***Data Link Control (DLC)***: The protocol used to connect to IBM mainframes and network-attached printers
- ***NetBIOS Enhanced User Interface (NetBEUI)***: An enhanced set of network and transport protocols built in the late 1980s to carry NetBIOS information, when earlier implementations became too limiting for continued use
- ***NWLink***: Microsoft's 32-bit implementation of Novell's NetWare native protocol stack, IPX/SPX (Internetwork Protocol Exchange/Sequenced Packet Exchange)
- ***TCP/IP (Transmission Control Protocol/Internet Protocol)***: The set of protocols used on the Internet, which has been embraced by Microsoft as a vital technology

Windows 2000 is compatible with many existing network types and environments, and it has native support for the following:

- TCP/IP intranets/Internet
- Integrated remote access networks
- Macintosh networks
- Microsoft networks (MS-DOS, Windows for Workgroups, LAN Manager)
- Enhanced NetWare connectivity

Windows 2000 Professional Hardware Requirements

Windows 2000 Professional requires a minimum configuration of hardware to function. It is important that your system comply with these minimum requirements. However, in nearly all cases, you should attempt to purchase the fastest, largest, or best device you can afford. The minimum requirements will enable functionality but will not provide optimum performance. Here are the Microsoft-defined minimum requirements:

- 166 MHz Pentium or higher microprocessor (P5 or equivalent compatible clone)
- 32 MB of RAM for Intel (64 MB or more recommended; 4 GB maximum)
- 2 GB hard disk with a minimum of 650 MB of free space
- VGA or higher resolution monitor
- Keyboard
- Microsoft Mouse or compatible pointing device (optional)

If you are installing from a CD-ROM drive, you'll need:

- A CD-ROM drive (12X or faster recommended)
- High-density 3.5-inch disk drive, unless you configured your PC to boot from the CD-ROM drive, and can start the Setup program from a CD, or if you have an existing OS that can access the CD-ROM drive

If you are installing over a network (Intel only), you'll need:

- Windows 2000-compatible network interface card (NIC) and related cable
- Access to the network share that contains the setup files

Hardware Compatibility List (HCL)

When it comes to configuring a Windows 2000 machine, the Microsoft **hardware compatibility list (HCL)** is an essential piece of documentation. The HCL supplies a

list of all known Windows 2000-compatible hardware devices at the time of its creation. The HCL also points to each device's driver—which may be native (included as part of the Windows 2000 installation program), on a subdirectory on the Windows 2000 CD, or available only from the device's vendor. Because Windows 2000 works properly only if a system's hardware is Windows 2000-compatible, it's always a good idea to use the HCL as your primary reference when evaluating a prospective Windows 2000 system, or when selecting components for such a system.

Finding the HCL

Finding the HCL is not always easy. The easiest place to look is on your Windows 2000 CD-ROM, where it resides in the Support folder as a text and a Help file. But the HCL is not a static document—Microsoft's Quality Labs are constantly updating this file. The version of the HCL on the Windows 2000 CD-ROM will quickly become outdated because lots of new drivers and devices are introduced on a regular basis.

It's a good idea to look for the most current version of the HCL, especially when you'll be working with brand-new hardware. The most recent version of the HCL is available for online viewing on Microsoft's Web site at: *http://www.microsoft.com/hcl/default.asp*. On the other hand, if you have access to a copy of the TechNet CD, a new copy is published each time it changes, so the most recent CD is guaranteed to be less than four months old.

Why the HCL Is So Important

Windows 2000 controls hardware directly; unlike other operating systems, it does not require access to a PC's BIOS (basic input/output system) as is the case with Windows 95/98 and earlier versions of DOS and Windows. Although this gives Windows 2000 a much finer degree of control over hardware, it also means that Windows 2000 works only with devices with drivers written specifically for its use. This is especially true for SCSI adapters, video cards, and network interface cards.

Don't be misled into thinking that because a device works with Windows 95 or Windows 98, or even with Windows NT, that it will work as well (or at all) with Windows 2000. There's no substitute for systematically checking every hardware device on a system against the HCL to determine conclusively whether it will work with Windows 2000.

In addition, it is important to note that Microsoft's technical support policy is that any hardware that is not on the HCL is not supported for Windows 2000. If you ask Microsoft for support on a system that contains elements not listed in the HCL, they may blame all problems on the incompatible hardware, and not provide any support at all.

Fortunately, Windows 2000 automatically investigates your hardware and determines whether the minimum requirements are met and if any known incompatibilities or possible device conflicts are present in the system. So, if you check out the major components manually on the HCL, you can probably get away with letting the installation routinely check the rest of the system. If you *really* want to be sure your components are compatible, you can employ the Windows 2000 Hardware Compatibility Tool to detect your hardware and declare it compatible or not. This tool can be ordered online at: *http://www.microsoft.com/hwtest/default.asp*.

Preparing a Computer to Meet Upgrade Requirements

To upgrade a computer from a previous operating system to Windows 2000, you must first verify that the components of the computer match or supercede the minimum system requirements. Preparing a computer to meet upgrade requirements simply means you need to verify that each of the main system components (CPU, memory, storage space, video, keyboard, mouse, etc.) meet the requirements defined by Microsoft. To perform this activity, follow these steps:

1. Open the computer case.
2. Make a list of all present components including model and maufacturer.
3. For each of the hardware requirements of Windows 2000, verify that the component in your computer meets or exceeds the requirements.
4. For each additional component found in the computer, verify that it is listed on the HCL.
5. Remove any non-HCL compliant devices and replace them with HCL-compliant devices.
6. Proceed with your system installation.

Features of Windows 2000 Professional

Windows 2000 combines Windows NT and Windows 98 features and capabilities with newly developed technologies. This section highlights some of the more outstanding features of Windows 2000 Professional.

Ease of Use

Building on the intuitive interface of Windows NT 4.0 and Windows 98, Windows 2000 offers even more features to simplify computer interaction, including:

- The Start menu automatically displays only the most commonly accessed items, making it easier to locate often-accessed tools.
- Dialog boxes for opening and saving files provide more detailed information (see Figure 1-1).
- Error messages are more detailed and context driven to aid in problem resolution.

- New Control Panel wizards simplify hardware installation and configuration (see Figure 1-2).
- AutoComplete remembers previously used text strings, allowing for quick reaccess.
- Customized toolbars and personalized menus are available in most native utilities.
- Improved network connections simplify the establishment and tuning of network connections of all types (including RAS/DUN, VPN, LAN, WAN, and direct connections).

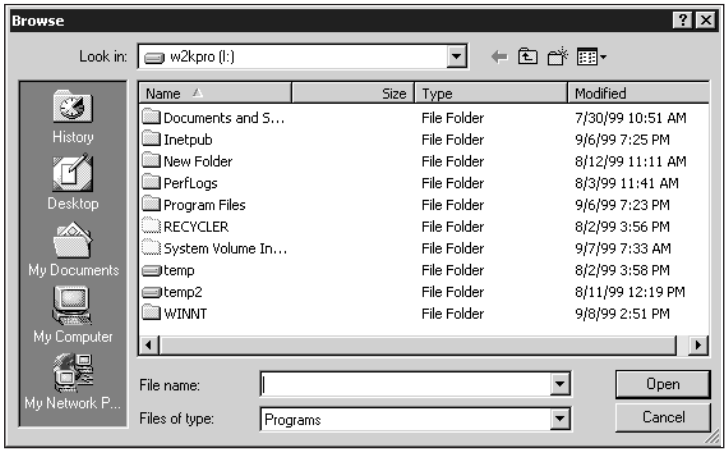

Figure 1-1 Dialog boxes now contain more detailed information

Figure 1-2 The Windows 2000 Professional Control Panel

Storage Improvements

Windows 2000 offers several storage-related improvements. Support for the popular Windows 98 (and Windows 95 OSR2) file system FAT32 is included. NTFS has been improved with support for EFS (Encrypting File System), enhanced content indexing to speed searches, and improved file object properties for identifying and grouping file objects. A disk defragmentation tool (see Figure 1-3) and a disk cleaning tool (which locates and removes orphaned files) have been added to the disk tool arsenal.

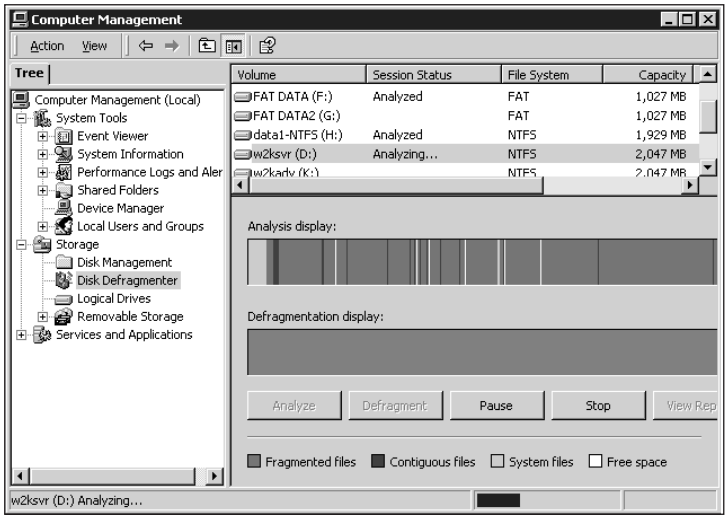

Figure 1-3 The Windows 2000 defragmentation tool

Internet Access

Interacting with the Internet has also been enhanced. AutoComplete allows quick reaccess to previously typed URLs or when filling out Web-based forms. A search assistant (see Figure 1-4) can help locate resources more efficiently. Printing to URLs, browser-based print queue status, and Internet downloadable printer drivers are all new features of the Windows 2000 Internet capabilities.

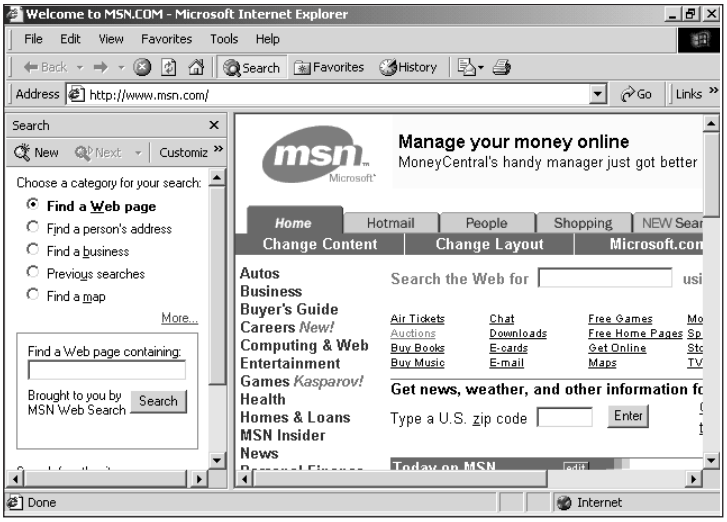

Figure 1-4 The Search tool

Security

Windows 2000 builds on the existing security structure of Windows NT and provides several enhancements. The most publicized enhancement is the use of the Kerberos authentication protocol to verify the server and client before communication over a LAN or WAN link is permitted. EFS, an extension of NTFS, allows files and volumes to be encrypted using a public-key scheme to prevent unauthorized access to confidential files. VPN (virtual private network) security is improved by the addition of the IPSec and L2TP protocols (for PPTP). Windows 2000 also includes support for smart cards—credit-card-sized devices that store information about the user who carries them, which is authenticated using a personal identification number—and other physical authentication methods.

Networking Models

There are two networking models to which a Windows 2000 Professional computer can belong: a **workgroup** or a domain.

Workgroup Model

Microsoft's **workgroup model** for networking distributes resources, administration, and security throughout a network. Each computer in a workgroup may be either a server or a client, or both. All computers in a workgroup are equal in stature and responsibility, and are therefore called peers. That's why a workgroup model network is also known as a **peer-to-peer** network.

In a workgroup, each computer also maintains its own unique set of resources, accounts, and security information. Workgroups are quite useful for groups of less than 10 computers, and

may be used with groups as large as 25 to 50 machines (with increasing difficulty). Table 1-1 lists the pros and cons of workgroup networking.

Table 1-1 Pros and Cons of Workgroup Networks

Advantages	Disadvantages
Easy-to-share resources	No centralized control of resources
Resources are distributed across all machines	No centralized account management
Little administrative overhead	No centralized administration
Simple to design	No centralized security management
Easy to implement	Inefficient for more than 20 workstations
Convenient for small groups in close proximity	Requires user accounts on each peer
Less expensive, does not require a central server	Increased training to operate as both client and server

Domain Model

By requiring one or more servers to be dedicated to the job of controlling a domain, the **domain model** adds a layer of complexity to networking. But the domain model also centralizes all shared resources, and creates a single point of administrative and security control. In a domain, it is recommended that any member of the domain act exclusively either as a client or as a server. In a domain environment, servers control and manage resources, whereas clients are user computers that may request access to whatever resources are controlled by servers.

Its centralized organization makes the domain model simpler to manage from an administrative and security standpoint, because any changes made to the domain accounts database will automatically proliferate across the entire network. According to Microsoft, domains are useful for groups of 10 or more computers. Microsoft estimates that the maximum practical size of a single domain is somewhere around 25,000 computers, but also describes other multidomain models that it claims can grow to almost arbitrary sizes. In real-world application, 3000 computers is believed to represent a reasonable upper boundary on the number of machines in a single domain.

No matter how many computers it contains, any Windows 2000 domain requires at least one **domain controller (DC)**. The domain controller maintains the domain's Active Directory, which stores all information and relationships about users, groups, policies, computers, and resources. More than one domain controller can exist in a domain. In fact, it is recommended that you deploy a domain controller for every 300 to 400 clients. Unlike domain controllers in a Windows NT 4.0 network, all Windows 2000 domain controllers are peers. All other servers and clients on a domain-based network interact with a domain controller to handle resource requests. Table 1-2 summarizes the pros and cons of the domain model.

Table 1-2 Pros and Cons of Domain Networks

Advantages	Disadvantages
Centralized resource sharing	Significant administrative effort and overhead
Centralized resource controls	Complicated, convoluted designs
Centralized account management	Requires one or more powerful, expensive servers
Centralized security management	Bulletproof security is hard to achieve
Efficient for virtually unlimited workstations	Expense for domain controllers and access lags increases with network size
Users only need to be trained to use clients	Some understanding of domain networks remains necessary
Not restricted to close proximity	Larger scope requires more user documentation and training

WINDOWS 2000 ARCHITECTURE

The Windows 2000 internal organization and **architecture** deeply influence its capabilities and behavior. The following sections explain the Windows 2000 operating system components and its two major operating modes in detail.

Windows 2000 is a modular operating system. In other words, Windows 2000 is not built as a single, large program; instead, it is composed of numerous small software elements, or modules, that cooperate to provide the system's networking and computing capabilities. Each unique function, code segment, and system control resides in a distinct module, so that no two modules share any code. This method of construction allows Windows 2000 to be easily amended, expanded, or patched as needed. Furthermore, the Windows 2000 components communicate with one another through well-defined interfaces. Therefore, even if a module's internals change (or a new version replaces an old one), as long as the interface is not altered, other components need not be aware of any such changes (except perhaps to take advantage of new functionality that was hitherto unavailable).

All Windows 2000 processes operate in one of two modes: **user mode** or **kernel mode**. A **mode** represents a certain level of system and hardware access, and is distinguished by its programming, the kinds of services and functions it is permitted to request, and the controls that are applied to its requests for system resources. Each mode contains only whatever specific components and capabilities might be needed to perform the set of operations that is legal within that mode. The details of what's inherent to user mode and kernel mode are explained further in the following sections. The use of modes in Windows 2000 is very similar to their use in Unix and VMS, and provides further proof of the modularity and built-in security mechanisms in Windows 2000.

Windows 2000 is an object-oriented operating system; in user mode, any request for a system resource ultimately becomes a request for a particular **object**. An object is a collection of attributes with associated data values, plus a set of related services that can be performed on that object. Files, folders, printers, and processes are examples of objects. Because objects may be shared or referenced by one or more processes, they have an existence independent of any particular process in the Windows 2000 environment. Objects are identified by type (which defines what attributes and services they support) and by instance (which defines a particular entity of a certain type—for example, there may be many objects of type "file," but only one object can have a particular unique combination of directory specification and filename). Windows 2000 can control access to individual objects, and it can even control which users or groups are permitted to perform particular services related to such objects.

User Mode

All user interaction with a Windows 2000 system occurs through one user mode process. User mode is an isolated portion of the system environment in which user applications execute. User mode is permitted only mediated access to Windows 2000 system resources. In other words, any user mode requests for objects or services must pass through the Executive Services components in the kernel mode to obtain access. In addition to supporting native 32-bit Windows **APIs (application programming interfaces)**, a variety of user mode subsystems enable Windows 2000 to emulate Win16 and DOS environments, and even permit OS/2 character mode and POSIX.1-compliant software to be executed.

Windows 2000 supports three core environment subsystems:

- *Win32*: Supports Windows 2000, Windows NT, Windows 95, and Windows 98 32-bit applications directly, and, through emulation of virtual DOS machines (VDMs), supports both Windows 16-bit and DOS applications
- *POSIX*: Supports POSIX.1 applications, but these have only limited functionality; third-party solutions (most notably, those from SoftWay Systems) offer considerably more powerful and capable POSIX implementations for Windows 2000
- *OS/2*: Supports character-mode OS/2 1.1 applications (unfortunately, this makes most modern GUI-based OS/2 applications unusable in this environment; here, adds-ons to extend this functionality are available from Microsoft and third parties)

Each subsystem is built around an API that enables suitable Win16, DOS, OS/2, or POSIX applications to run by emulating their native operating systems. But even though other subsystems may be involved in some applications, the Win32 subsystem controls the Windows 2000 user interface and mediates all input/output requests for all other subsystems. In that sense, it is the core interface subsystem for applications in user mode.

As part of the Windows 2000 user mode, the security subsystem is solely responsible for the logon process. The security subsystem works directly with key elements in the kernel mode to verify the username and password for any logon attempt, and permits only valid combinations to obtain access to a system. Here's how: When a logon attempt occurs, the security subsystem creates an authentication package that contains the username and password

provided in the Windows 2000 Security logon window. This authentication package is then turned over to the kernel mode, where a module called the security reference monitor (SRM)—the portion of the security subsystem that verifies usernames and passwords against the security accounts database—examines the package and compares its contents to a security accounts database. If the logon request is invalid, an incorrect logon message is returned to the user mode. For valid requests, the SRM constructs an access token, which contains a summary of the logged-on user's security access rights. The token is then returned to the Security subsystem used to launch the shell process in user mode.

To gain access to the logon interface of Windows 2000, the user must enter a special key combination called the Windows 2000 attention sequence. This is done by pressing Ctrl+Alt+Delete simultaneously. The attention sequence invokes the Windows 2000 logon process; because this key sequence cannot be faked remotely, it guarantees that this process (which also resides in a protected memory area) is not subject to manipulation by would-be crackers.

Kernel Mode

The kernel mode, which is a highly privileged processing mode, defines the inner workings, or **kernel**, of Windows 2000. All components in kernel mode take execution priority over user mode subsystems and processes. In fact, some key elements within the kernel mode remain resident in memory at all times, and cannot be swapped to disk by the Virtual Memory Manager. This is the part of the operating system that handles process priority and scheduling (it's what provides the ability to preempt executing processes and schedule new processes, which is at the heart of any preemptive multitasking operating system, such as Windows 2000).

The kernel insulates hardware and core system services from direct access by user applications. That's why user applications must request any accesses to hardware or low-level resources from the kernel mode. If the request is permitted to proceed—and this mediated approach always gives Windows 2000 a chance to check any request against the access permitted by the access token associated with the requester—the kernel handles the request and returns any related results to the requesting user mode process. This mediated approach also helps maintain reliable control over the entire computer and protects the system from ill-behaved applications. At a greater level of detail, the kernel mode may be divided into three primary subsystems. These are the Executive Services, the kernel, and the hardware abstraction layer (HAL), each of which is discussed in the following subsections.

Executive Services

The **Executive Services** define the interfaces that permit kernel and user mode subsystems to communicate. The Windows 2000 Executive Services consist of several modules:

- I/O Manager
- Security Reference Monitor (SRM)
- Internal Procedure Call (IPC) Manager
- Virtual Memory Manager (VMM)

- Process Manager
- Plug and Play Manager
- Power Manager
- Windows Manager
- File Systems Manager
- Object Manager
- Graphics device drivers

The I/O Manager handles all operating system input and output. The I/O Manager receives requests for I/O services from applications, determines what driver is needed, and requests that driver for the application. The I/O Manager is composed of the following components:

- *Cache Manager*: Handles disk caching for all file systems. This service works with the Virtual Memory Manager to maintain performance. It also works with the file system drivers to maintain file integrity.
- *Network drivers*: Actually a subarchitecture in and of itself, network drivers are the software components that enable communication on the network.
- *Device drivers*: Minidrivers that are 32-bit and multiprocessor-compatible that enable communication with devices.

The Security Reference Monitor compares the access rights of a user (as encoded in an access token) with the access control list (ACL) associated with an individual object. If the user has sufficient rights to honor an access request after the access token and ACL are reconciled, the requested access will be granted. Whenever a user launches a process, that process runs within the user's security context, and inherits a copy of the user's security token. This means that under most circumstances, any process launched by a Windows 2000 user cannot obtain broader access rights than those associated with the account that launched it.

The Internal Procedure Call (IPC) Manager controls application communication with server processes such as the Win32 subsystem—the set of application services provided by the 32-bit version of Microsoft Windows. This makes applications behave as if **dynamic link library (DLL)** calls are handled directly, and helps to explain the outstanding ability of Windows 2000 to emulate 16-bit DOS and Windows run-time environments.

The **Virtual Memory Manager (VMM)** keeps track of the addressable memory space in the Windows 2000 environment. This includes both physical RAM and one or more paging files on disk, which are called **virtual memory** when used in concert. The operation of the VMM will be discussed in more detail later in this chapter.

The Process Manager primarily tracks two kernel-dispatched objects: processes and threads. It is responsible for creating and tracking processes and threads, and then for deleting them (and cleaning up) after they're no longer needed.

The Plug and Play Manager handles the loading, unloading, and configuration of device drivers for Plug and Play hardware. This manager allows the hot-swapping of devices and

on-the-fly reconfiguration. Additionally, if a non-Plug-and-Play device uses a Plug-and-Play supporting device driver, it can be controlled through this manager.

The Power Manager is used to monitor and control the use of power. Typically, the services offered by the Power Manager are employed on notebook computers running on batteries or in other environments in which power is an issue. Some of the power-saving features offered include hard drive and CD-ROM drive power down, video/monitor shutdown, and peripheral disconnection.

The Windows Manager introduces a method of network-based centralized control to Windows 2000. It can be used to distribute software, manage systems remotely, and provide a programming interface for third-party management software.

The File System Manager is responsible for maintaining access and control over the file systems of the Windows 2000 environment. The File System manager controls file I/O transfers for all the file systems. Each 32-bit, protected-mode redirector is implemented as a file system driver.

The Object Manager manages all system objects by maintaining object naming and security functions. It allocates system objects, monitors their use, and removes them when they are no longer needed. The Object Manager maintains the following system objects:

- Directory objects
- ObjectType objects
- Link objects
- Event objects
- Process and Thread objects
- Port objects
- File objects

The Kernel

All processes in Windows 2000 consist of one or more threads coordinated and scheduled by the kernel. Executive Services use the kernel to communicate with each other concerning the processes that they share. The kernel runs in privileged mode along with the HAL and the other Executive Services. This means that the kernel is allowed direct access to all system resources. It cannot be paged to disk, meaning that it must run in real memory. A misbehaved kernel process can stall or crash the operating system—a primary reason why direct access to this level of system operation is not available to user mode applications.

The Hardware Abstraction Layer (HAL)

The **hardware abstraction layer (HAL)** ultimately controls all direct access to hardware. This is the only module written entirely in low-level, hardware-dependent code. Its goal is to isolate any hardware-dependent code in order to prevent direct access to hardware. It is the HAL that helps to make Windows 2000 scaleable across multiple processors.

Memory Architecture

The memory architecture of Windows 2000 helps make this operating system robust, reliable, and powerful. As noted earlier, Windows 2000 Professional can manage as much as 4 GB of RAM.

Windows 2000 uses a flat (non-multidimensional) 32-bit memory model. It is based on a virtual memory, **demand paging** method that is a flat, linear address space of up to 2 GB allocated to each 32-bit application. Non-32-bit Windows applications, such as Win16, MS-DOS, and OS/2, are managed similarly except that all subsystem components, including the actual application, run within a single 2 GB address space.

The unit of memory that the Virtual Memory Manager manipulates is called a **page**. A page is 4 KB in size. Pages are stored to and retrieved from disk-based files called page files or paging files. These files are also used for memory reindexing and mapping to avoid allocating memory between unused contiguous space or to prevent fragmentation of physical memory.

The Windows 2000 memory model is a flat model that grows according to the demand for memory, as opposed to every section of memory having a fixed role (as in the problematic Conventional, Expanded, HMA, and Extended Memory architecture present in MS-DOS and Windows 3.x).

Chapter Summary

- This chapter introduced you to the features and architecture of Windows 2000. Windows 2000 is a product family with at least four members: Professional, Server, Advanced Server, and Datacenter Server. Windows 2000 offers a distinct operating environment, which boasts portability, multitasking, multithreading, multiple file systems (FAT, FAT32, NTFS), Active Directory, robust security, multiple clients, multiple processors, wide application support, large RAM and storage capacity, and a wide range of network connectivity options. Windows 2000 is an inherently networkable operating system with built-in connectivity solutions for NetWare, Macintosh, and TCP/IP. This allows easy implementation on multivendor networks.
- Windows 2000 has specific minimum hardware requirements for the Intel platform. Additionally, the hardware compatibility list (HCL) lists all devices known to be compatible with Windows 2000.
- Windows 2000 can participate in either of two networking models—workgroup or domain.
- Windows 2000 is based on a modular programming technique. Its main processing mechanism is divided into two modes. User mode hosts all user processes and accesses resources via the Executive Services. The kernel mode hosts all system processes and mediates all resource access. The separation of modes provides for a more stable and secure computing environment. User mode supports the application subsystems that enable Windows 2000

to execute DOS, WIN16, WIN32, POSIX, and OS/2 software. Kernel mode's Executive Services manage all operations, including I/O, security, IPC, memory, processes, Plug and Play support, power, distributed control, file systems, objects, and graphical devices.

- The Windows 2000 virtual memory model combines the use of both physical RAM and paging files into a demand paging mechanism to maximize memory use and efficiency. Windows 2000 is easy to use, offers new storage capabilities, provides improved Internet access, and maintains strict security.

KEY TERMS

Active Directory — A centralized resource and security management, administration, and control mechanism used to support and maintain a Windows 2000 domain. The Active Directory is hosted by domain controllers.

AppleTalk — The network protocol stack used predominantly in Apple Macintosh networks; this protocol is bundled with Windows 2000.

application programming interface (API) — A set of software routines referenced by an application to access underlying application services.

architecture — The layout of operating system components and their relationships to one another.

client — A computer used to access network resources.

cooperative multitasking — A computing environment in which the individual application maintains control over the duration that its threads use operating time on the CPU.

Data Link Control (DLC) — A low-level network protocol designed for IBM connectivity, remote booting, and network printing.

demand paging — The act of requesting free pages of memory from RAM for an active application.

domain — A centralized enterprise model used in Microsoft networks.

domain controller (DC) — A computer that maintains the domain's Active Directory, which stores all information and relationships about users, groups, policies, computers, and resources.

domain model — The networking setup in which there is centralized administrative and security control. One or more servers are dedicated to the task of controlling the domain, providing access and authentication for shared domain resources to member computers.

dynamic link library (DLL) — A Microsoft Windows executable code module that is loaded on demand. Each DLL performs a unique function or small set of functions requested by applications.

Executive Services — The collection of kernel mode components designed for operating system management.

FAT (file allocation table) or **FAT16** — The file system used in versions of MS-DOS. Supported in Windows 2000 in its VFAT form, which adds long filenames and 4 GB file and volume sizes.

FAT32 — The 32-bit enhanced version of FAT introduced by Windows 95 OSR2, and which expands the file and volume size of FAT to 32 GB. FAT32 is supported by Windows 2000.

hardware abstraction layer (HAL) — One of the few components of the Windows 2000 architecture that is written in hardware-dependent code. It is designed to protect hardware resources.

hardware compatibility list (HCL) — Microsoft's updated list of supported hardware for Windows 2000.

Kerberos — An encryption authentication scheme employed by Windows 2000 to verify the identity of a server and a client before actual data is transferred.

kernel — The core of the Microsoft Windows 2000 operating system. It is designed to facilitate all activity within the Executive Services.

kernel mode — The level where objects can only be manipulated by threads directly from an application subsystem.

mode — A programming and operational separation of components, functions, and services.

MS-DOS — One of the most popular character-based operating systems for personal computers. Many DOS concepts are still in use by modern operating systems.

multiprocessing — The ability to distribute threads among multiple CPUs on the same system.

multitasking — The ability to run more than one program at the same time.

multithreading — The ability of an operating system and hardware to execute multiple pieces of code (or threads) from a single application simultaneously.

New Technology File System (NTFS) — The high-performance file system supported by Windows 2000, which offers file-level security, encryption, compression, auditing, and more. Supports volumes up to 16 Exabytes theoretically, but Microsoft recommends volumes not exceed 2 Terabytes.

NWLink — Microsoft's implementation of Novell's IPX/SPX protocol, used for Microsoft Networking or for facilitating connectivity with Novell networks.

object — A collection of data and/or abilities of a service that can be shared and used by one or more processes.

operating system — Software designed to work directly with hardware to provide a computing environment within which production and entertainment software can execute, and which creates a user interface to allow human interaction with the computer.

OS/2 — An operating system developed by IBM. Windows 2000 offers some OS/2 application support.

page — An individual unit of memory that the Virtual Memory Manager manipulates (moves from RAM to paging file and vice versa).

peer-to-peer — A type of networking in which each computer can be a client to other computers, and act as a server as well.

Plug and Play — The ability of Windows 2000 to recognize hardware, automatically install drivers, and perform configuration changes on the fly.

POSIX — A subsystem that is sanctioned by the IEEE for maintaining consistency between Windows 2000 and various flavors of Unix.

preemptive multitasking — A computing environment in which the operating system maintains control over the duration of operating time any thread (a single process of an application) is granted on the CPU.

process — A collection of one or more threads.

server — The networked computer that responds to client requests for network resources.

TCP/IP (Transmission Control Protocol/Internet Protocol) — A suite of protocols evolved from the Department of Defense's ARPANet. It is used for connectivity in LANs as well as the Internet.

thread — The most basic unit of programming code that can be scheduled for execution.

user mode — The area in which private user applications and their respective subsystems lie.

virtual memory — A Windows 2000 kernel service that stores memory pages that are not currently in use by the system in a paging file. This frees up memory for other uses. Virtual memory also hides the swapping of memory from applications and higher-level services.

Virtual Memory Manager (VMM) — The part of the operating system that handles process priority and scheduling, providing the ability to preempt executing processes and schedule new processes.

Win16 — The subsystem in Windows 2000 that allows for the support of 16-bit Windows applications.

Win32 — The main 32-bit subsystem used by Win32 applications and other application subsystems.

Windows 2000 Advanced Server — The new Microsoft network operating system (NOS) version designed to function as a high-end resource on a network.

Windows 2000 Datacenter Server — An enhanced version of Windows 2000 Server developed to host high-end applications, as well as support data warehousing, real-time transaction processing, and enterprise Web site hosting.

Windows 2000 Professional — The new Microsoft NOS version designed to function as a client/workstation on a network.

Windows 2000 Server — The new Microsoft NOS version designed to function as a resource host on a network.

Windows 3.x — An older, 16-bit version of Windows. Windows 2000 supports backward compatibility with most Windows 3.x applications.

Windows 95 — The 32-bit version of Windows that can operate as a standalone system or in a networked environment.

Windows 98 — An updated version of Windows 95 with improved Internet and network connectivity.

Windows for Workgroups — A version of Windows 3.x that includes minimal network support to allow the software to act as a network client.

Windows NT — The Microsoft network operating system that was the predecessor to Windows 2000.

workgroup — A networking scheme in which resources, administration, and security are distributed throughout the network.

workgroup model — The networking setup in which users are managed jointly through the use of workgroups to which users are assigned.

Review Questions

1. Which of the following application environments does Windows 2000 support at least minimally?
   a. PICK
   b. SunOS
   c. OS/2
   d. X-Windows
2. Windows 2000 supports _____ of memory and _____ of disk space.
3. Which of the following are kernel mode components in Windows 2000? (Choose all that apply.)
   a. Virtual DOS machines
   b. Security Reference Monitor
   c. hardware abstraction layer
   d. Win16 subsystem
4. Windows 2000 supports only cooperative multitasking. True or False?
5. Windows 2000 supports the HPFS file system. True or False?
6. Windows 2000 has inherent support for facilitating connectivity to which of the following? (Choose all that apply.)
   a. Novell NetWare
   b. Macintosh printers
   c. Linux
   d. TCP/IP networks

7. Memory pages are stored in units of:
   a. 2 KB
   b. 4 KB
   c. 16 KB
   d. 64 KB
8. Which of the following operating systems can be used as a client on a Windows 2000 network? (Choose all that apply.)
   a. Windows for Workgroups
   b. Windows NT 4.0 Workstation
   c. MS-DOS
   d. Windows 98
9. If you want users to share resources, but have no concern for local security on the system, which operating system would be your best choice?
   a. Windows 98
   b. Windows NT Workstation
   c. Windows 2000 Professional
   d. Windows 2000 Advanced Server
10. Which of these configuration specifications will allow for the installation of Windows 2000 Professional? (Choose all that apply.)
    a. Intel 166 MHz Pentium, 32 MB of RAM, 2 GB disk space
    b. Compaq Alpha, 48 MB of RAM, 2 GB disk space
    c. Intel 486DX/66, 16 MB of RAM, 800 MB disk space
    d. Intel 133 MHz Pentium, 24 MB of RAM, 2 GB disk space
11. A dual-boot computer hosts both Windows 98 and Windows 2000 Professional. You need to download an 8 GB datafile, which will be used by both OSs. What file system should you use to format the host volume?
    a. FAT
    b. FAT32
    c. NTFS
12. You are setting up a computer for the purpose of sharing files. Each user connecting will need to have specific levels of access based on their identity. You also want the security system to employ encryption authentication to verify the identity of both the server and client before data transfer can occur. Which operating system would be the most effective solution?
    a. Windows 98
    b. Windows 2000 Professional
    c. Windows NT Workstation
    d. Windows 2000 Server

13. The two networking models supported in Windows 2000 are _____ and _____.
14. The three file systems supported in Windows 2000 are _____, _____, and _____.
15. When a user presses the Ctrl+Alt+Delete key combination in Windows 2000 after booting, what happens?
    a. The computer reboots.
    b. The logon screen appears.
    c. A "blue screen of death" occurs.
    d. A command prompt appears.
16. Windows 2000 runs on top of DOS. True or False?
17. Which of the following are required to install Windows 2000 on Intel-based computers?
    a. an SCSI CD-ROM drive
    b. a tape backup device
    c. a network interface card
    d. none of the above
18. Windows 2000 was designed by Microsoft to replace what other operating system?
    a. Windows 98
    b. Windows NT
    c. Windows for Workgroups
    d. Windows CE
19. Administrators desiring a centralized model of resource management should consider the _____ network model.
    a. workgroup
    b. domain
20. All direct access to hardware is mediated by which component?
    a. kernel
    b. Win32 subsystem
    c. hardware abstraction layer
    d. Executive Services
21. Windows 2000 Professional natively supports _____ processors.
    a. 1
    b. 2
    c. 4
    d. 32

22. Windows 2000 includes native support for what types of security hardware?
    a. voice recognition
    b. smart cards
    c. retinal scanners
    d. body heat imaging
23. Windows NT Professional clients can print to Macintosh printers using the AppleTalk protocol. True or False?
24. When a DOS application that is used to manipulate files on a hard drive is launched on a Windows 2000 Professional system, in what mode does the process execute?
    a. user
    b. kernel
    c. protected
    d. IPC
25. What supported platforms allow the installation of Windows 2000 to occur over a network? (Choose all that apply.)
    a. Intel
    b. PowerPC
    c. Compaq Alpha
    d. MIPS

HANDS-ON PROJECTS

Project 1-1

To explore the desktop:

1. Boot and log on to a Windows 2000 Professional system by pressing **Ctrl+Alt+Delete**.
2. Notice the icons on the desktop (see Figure 1-5).
3. Double-click **My Documents**. This reveals the default storage location for your personal documents, faxes, and pictures.
4. Click the **File** menu, then click **Close**.
5. Double-click **My Computer**. This reveals a list of all drives present on the system, plus a link to the Control Panel.
6. Click the **File** menu, then click **Close**.
7. Double-click **My Network Places**. This reveals the interface used to add new network connections, a link to the entire network, and a list of any recently accessed shares from the network.
8. Click the **File** menu, then click **Close**.

Figure 1-5 Windows 2000 Professional desktop

9. Double-click the **Recycle Bin**. This reveals all items that have been deleted but are still recoverable.
10. Click the **File** menu, then click **Close**.

Project 1-2

To explore the Start menu:

1. Click the **Start** button on the taskbar (see Figure 1-6).

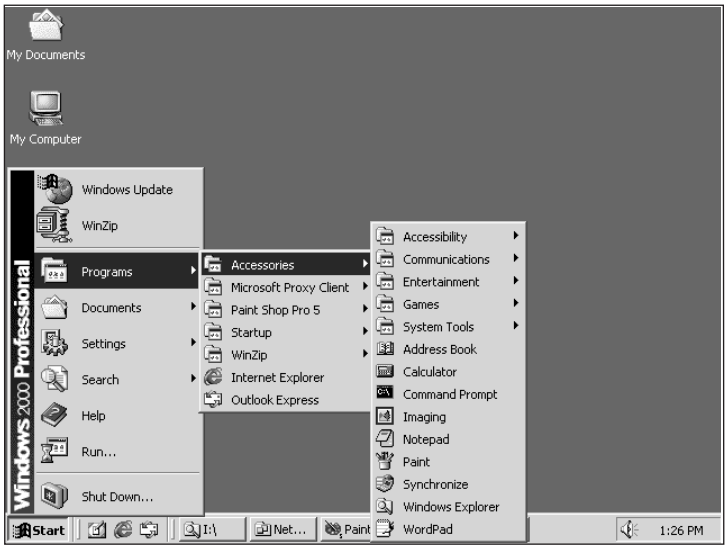

Figure 1-6 Start button items

2. Notice the items that occur in the Start menu by default: Windows Update, Programs, Documents, Settings, Search, Help, Run, and Shut Down.
3. Click **Shut Down**. This reveals a dialog box with a list where you can select to log off the current user account, restart, or shut down the system.
4. Click **Cancel**.
5. Click **Start**, then click **Run**. This reveals the Run dialog box, where you can enter a path and filename to launch.
6. Click **Cancel**.
7. Click **Start**, then click **Help**. This opens the Windows Help system. Explore this interface.
8. Close the Help system by clicking the Close button  in the upper-right corner of the dialog box.
9. Click **Start**, then point to **Search**. This opens a menu with three selections: For Files or Folders, On the Internet, and For People. Each of these is an interface used to locate file objects, Internet objects, or people, respectively.
10. Click **Start**, then point to **Settings**. This opens a menu with four items: Control Panel, Network and Dial-up Connections, Printers, and Taskbar & Start menu.
11. Click **Start**, then point to **Documents**. This opens a menu that lists fifteen of the most recently accessed documents or files.
12. Click **Start**, then point to **Programs**. This opens the first of several levels of menus in which all of the applications, tools, and utilities of the system are organized for easy access. Explore this multilevel menu.
13. Look at but don't select Windows Update. When launched, Windows Update attempts to connect to the Microsoft Web site. From the special update site, new files and updated components for Windows 2000 can be downloaded.

Project 1-3

To view the Windows 2000 administration tools:

1. Click **Start**, point to **Settings**, then point to **Control Panel**. This opens the Control Panel window (see Figure 1-7).
2. Notice the tools and utilities in the Control Panel.
3. Double-click the **Date/Time** applet. This reveals the Date/Time interface, where the current time and date can be changed.
4. Click **Cancel**.
5. Double-click the **Fonts** applet. This reveals a list of all the fonts currently present on the system.
6. Click **Back** in the button bar to return to the Control Panel.
7. Double-click **Administrative Tools**. This reveals all of the administrative tools for Windows 2000.

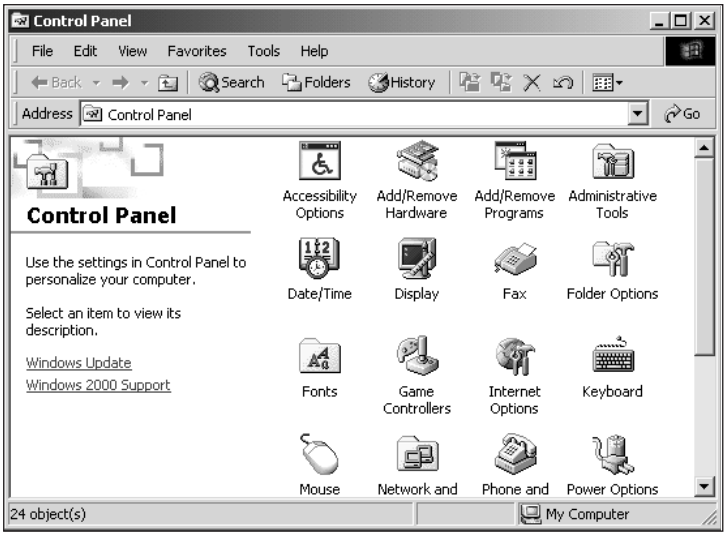

Figure 1-7 Control Panel tools

8. Double-click **Computer Management**. This opens an MMC console, where you can access information on a wide range of components. Explore this interface but be careful not to make any changes.
9. Close Computer Management by clicking ✕ in the upper-right corner of the window.
10. Click the **File** menu, then click **Close**.

Project 1-4

To explore Task Manager:

1. Right-click over a blank area of the taskbar. This reveals a menu. Select **Task Manager** from the menu.
2. Click the **Applications** tab of Task Manager (see Figure 1-8). This lists all applications currently active in user mode.
3. Click the **Processes** tab of Task Manager. This lists all processes currently active. It also lists details about each process such as its process ID, its CPU usage percentage per second, and its total CPU execution time.
4. Click the **Performance** tab of Task Manager. This tab shows graphs detailing the current and historical use of the CPU and memory. This tab also lists details about memory consumption, threads, and handles.
5. Click the **View** menu, then click **Show Kernel Times**. This alters the graphs so activities of the kernel mode are shown in red and activities of the user mode are shown in green.
6. After watching this interface for a while, close it by selecting **File**, **Exit Task Manager** from the menu.

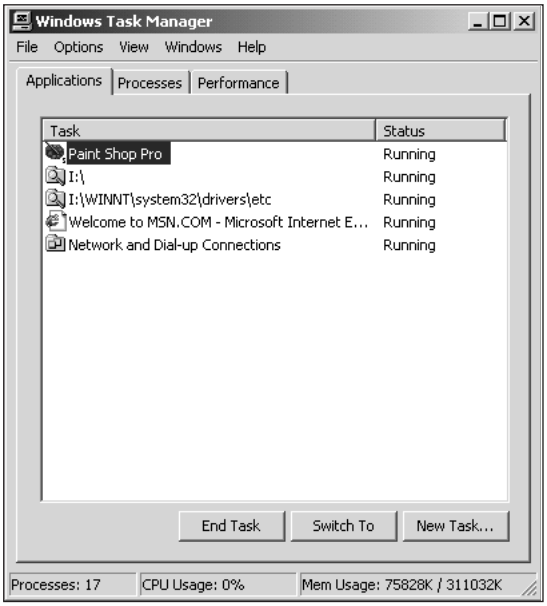

Figure 1-8 Task Manager, Applications tab

Project 1-5

To customize the Taskbar and Start menu:

1. Click **Start**, point to **Settings**, then click **Taskbar & Start Menu**.
2. On the **General** tab of the Taskbar & Start menu properties, notice the check boxes and their current selections.
3. Select the **Auto Hide** item. This causes the taskbar to slide off the screen when not in use. When you place the insertion point near the bottom of the screen, it will reappear.
4. Click the **Advanced** tab.
5. Click the **Clear** button to empty the Documents folder. This clears the list of recently accessed documents from the folder.
6. In the list of Start menu settings, select **Display Administrative Tools**, and **Expand Control Panel**.
7. Click **OK**.
8. Explore your changes. First, move the insertion point to the middle of the screen and click. Notice that the taskbar disappears. Move the insertion point near the bottom of the screen to watch the taskbar reappear.
9. Click **Start**, point to **Settings**, then point to **Control Panel**. Notice that a menu with all of the Control Panel contents is now present.

10. Click **Start**, point to **Programs**, then point to **Administrative Tools**. You may need to expand the menu by clicking the down arrows. This reveals a menu with the same contents as the Administrative Tools icon of the Control Panel.
11. Click a blank portion of the desktop to close the Administrative Tools menu.

Project 1-6

To customize the desktop:

1. Right-click a blank area of the desktop.
2. Select **New**, then **Shortcut** from the menu.
3. Click **Browse** in the window that appears.
4. Locate and select **Notepad.exe** in the main Windows 2000 directory (WINNT). Click **OK**.
5. Click **Next**.
6. Click **Finish**. A shortcut to Notepad now appears on the desktop.
7. Right-click over a blank area of the desktop.
8. Select **Arrange Icons**, then **Auto Arrange**.
9. Notice that the icons on the desktop have repositioned themselves in a uniform pattern.
10. **Right-click** over a blank area of the desktop.
11. Select **Properties**.
12. On the **Background** tab, take note of the current selection, then select an item from the list of background images.
13. Click **OK**.
14. To restore the desktop to its original settings, repeat steps 10–13 but use the original setting. Delete the shortcut you created by selecting it and pressing the **Delete** key, and then confirm the deletion.

CASE PROJECTS

1. You are planning a network in which users need to have a centralized location, where discretionary access control is a necessity. This will be an environment in which consistency is a must.

   Required Result

   - All users must be able to access the server from any computer within the network through a single logon.

   Optional Desired Results

   - Users must also be required to log on before accessing anything on their local machine.

- Users will have the exact same desktop GUI.

Proposed Solution

- Install Windows 2000 Server as the server platform. Establish a Windows 2000 domain. On half of the users' desktops, install Windows 98, and on the other half, install Windows 2000 Professional. Have all computers configured as part of the Windows 2000 domain.

Which results does the proposed solution produce? Why?

a. The proposed solution produces the required result and produces both of the optional desired results.

b. The proposed solution produces the required result, but only one of the optional desired results.

c. The proposed solution produces the required result, but neither of the optional desired results.

d. The proposed solution does not produce the required result.

2. You have been instructed to evaluate the status of the network environment at Site A. Your goal is to evaluate the current network and determine, first of all, whether upgrading is necessary. If so, then the next step is to determine which operating system will be the migration choice: Windows 2000 Professional or Windows 98. Finally, determine what steps need to occur before the migration can proceed.

   Site A has 220 computers currently running Windows 3.1. They are running all 16-bit applications from the DOS and Windows environments. They plan on migrating to Microsoft Office 2000. Each computer has the following hardware configuration:

   - Intel 486 DX4/100
   - 8 MB of RAM
   - 540 MB hard drive
   - NIC (network interface card)
   - VGA monitor

   Users will not be allowed to share files at the desktop. They will not roam from computer to computer, so all of their files can be stored locally on their own computers.

   Which migration path makes the most sense? Why?

   a. No migration

   b. Windows 2000 Professional

   c. Windows 98

   If migration to Windows 2000 Professional is necessary, what steps are necessary to establish optimum but cost-effective performance?